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(54) **Fuselage mounted undercarriage with tandem wheels**

(57) A fuselage mounted undercarriage for an aircraft has two rocker beams (3, 4) respectively carrying wheels (13, 15, 14, 16), the rocker beams (3, 4) being connected pivotably and respectively to two fixed points (7, 8) of the rigid structure of the aircraft. Each rocker beam (3, 4) is connected to two other fixed points (21, 22) of the aircraft structure by a respective connection (19, 20) comprising a lever (25, 26) and a shock absorber (27, 28) pivotably connected to each other at positions (42, 43), a connecting rod (41) of constant length connecting the two levers (25, 26) and an actuating cylinder (44) to rotate at least one (25) of the two levers. An up and down lock comprises a "breaking" strut (Fig. 4, not shown) between fixed point (7) and pivot (42), provided with an actuating cylinder. In the event of hydraulic failure, the pilot can use an auxiliary lever to "break" the strut, allowing gravity, aided by a tension spring, to lower the undercarriage and lock it.

FIG . 1

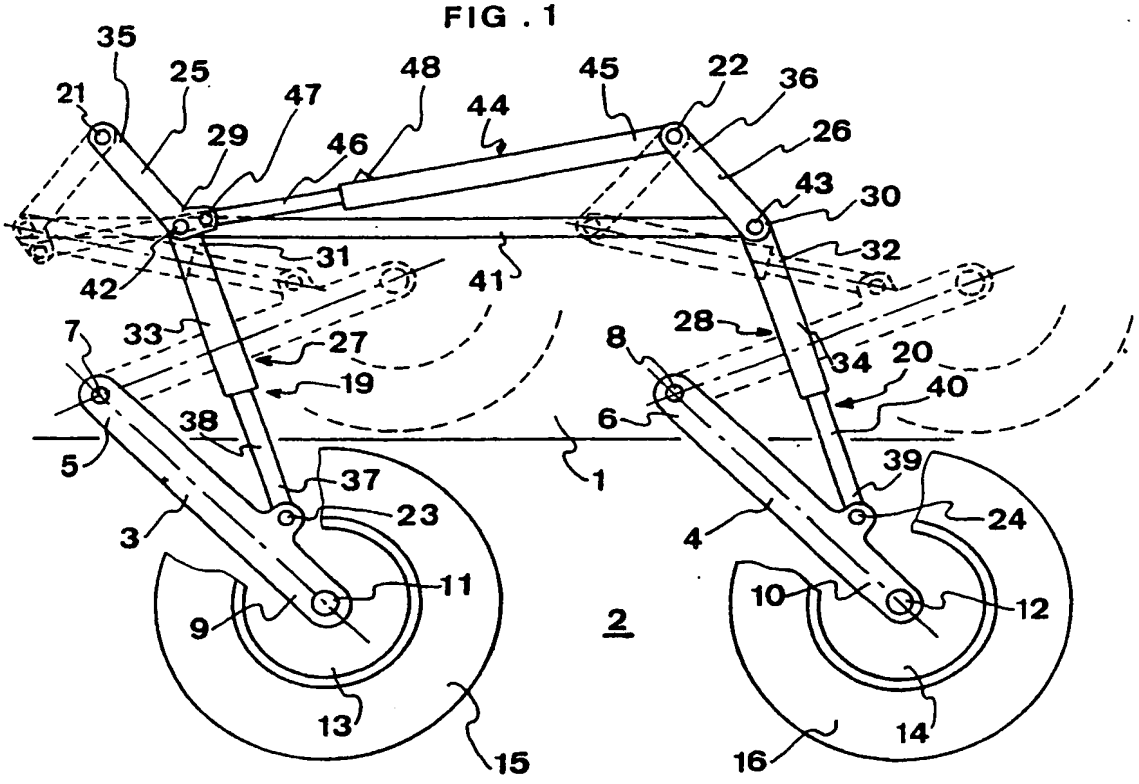

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FIG. 2

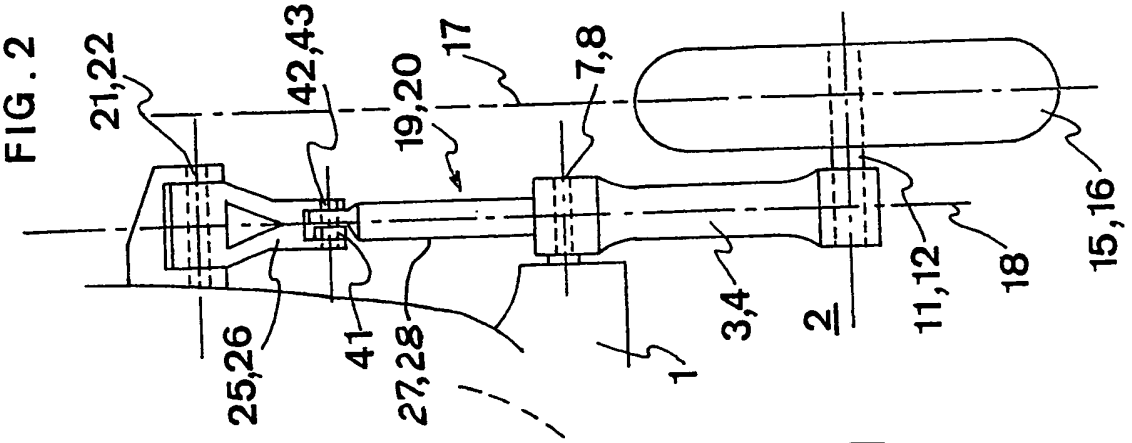
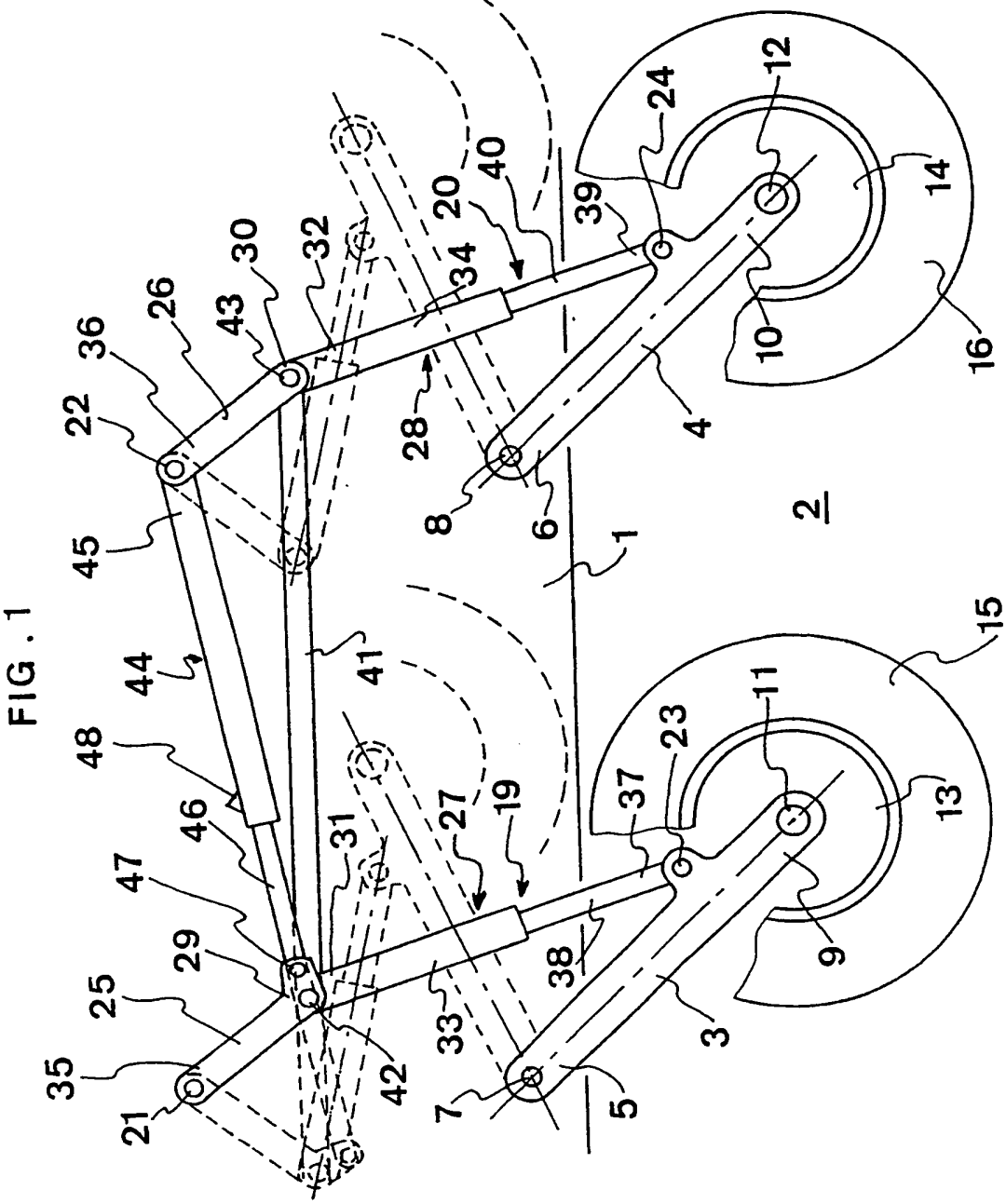

21,22
42,43
19,20
17
7,8
15,16
18
11,12
2
3,4
1
27,28
41
25,26

FIG. 1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12
14
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4
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28
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45
44
41
48
46
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29
25
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42
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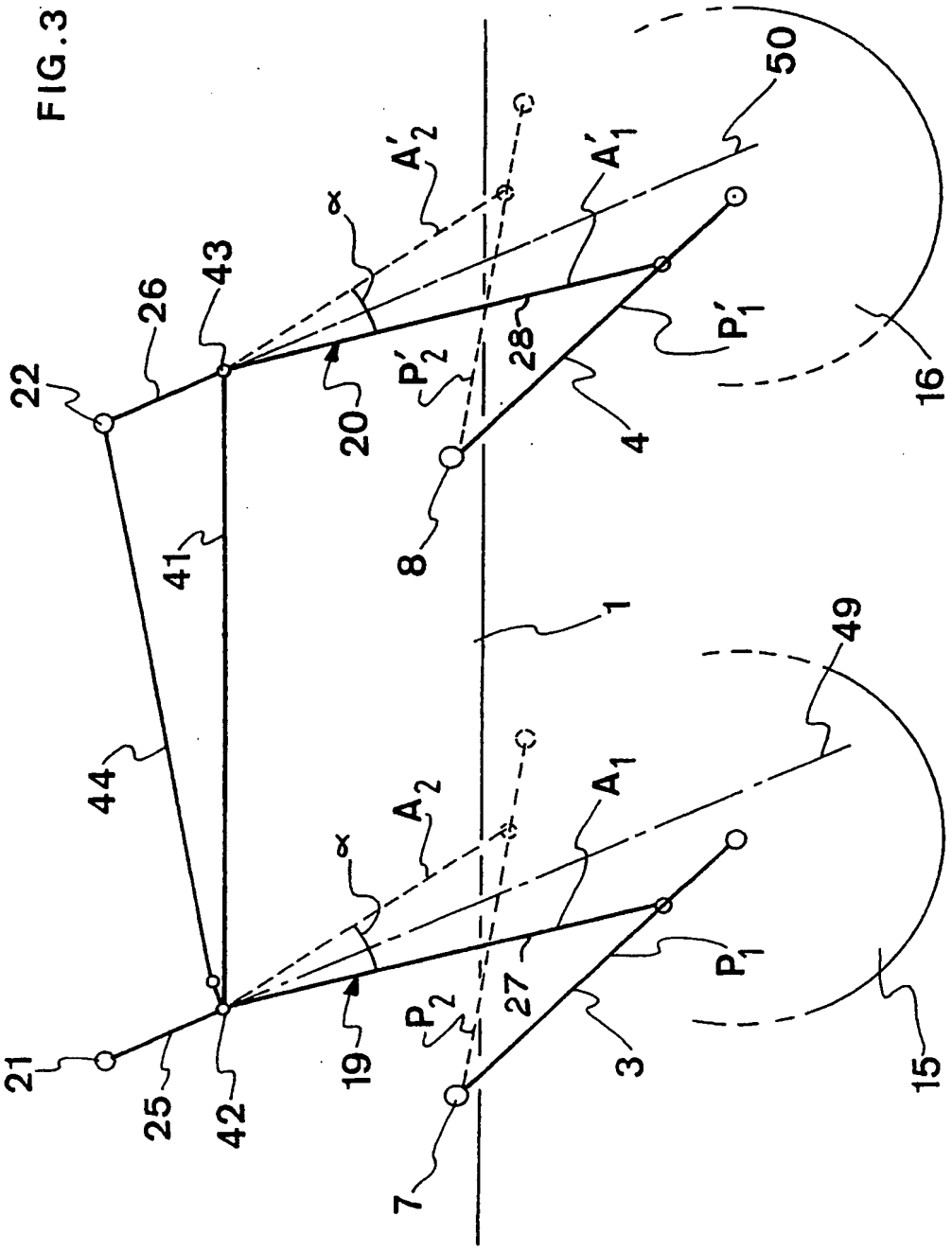
7
5

FIG.3


50
A'2
A'1
α
43
26
22
P'2
28
P'1
20
4
16
8
41
1
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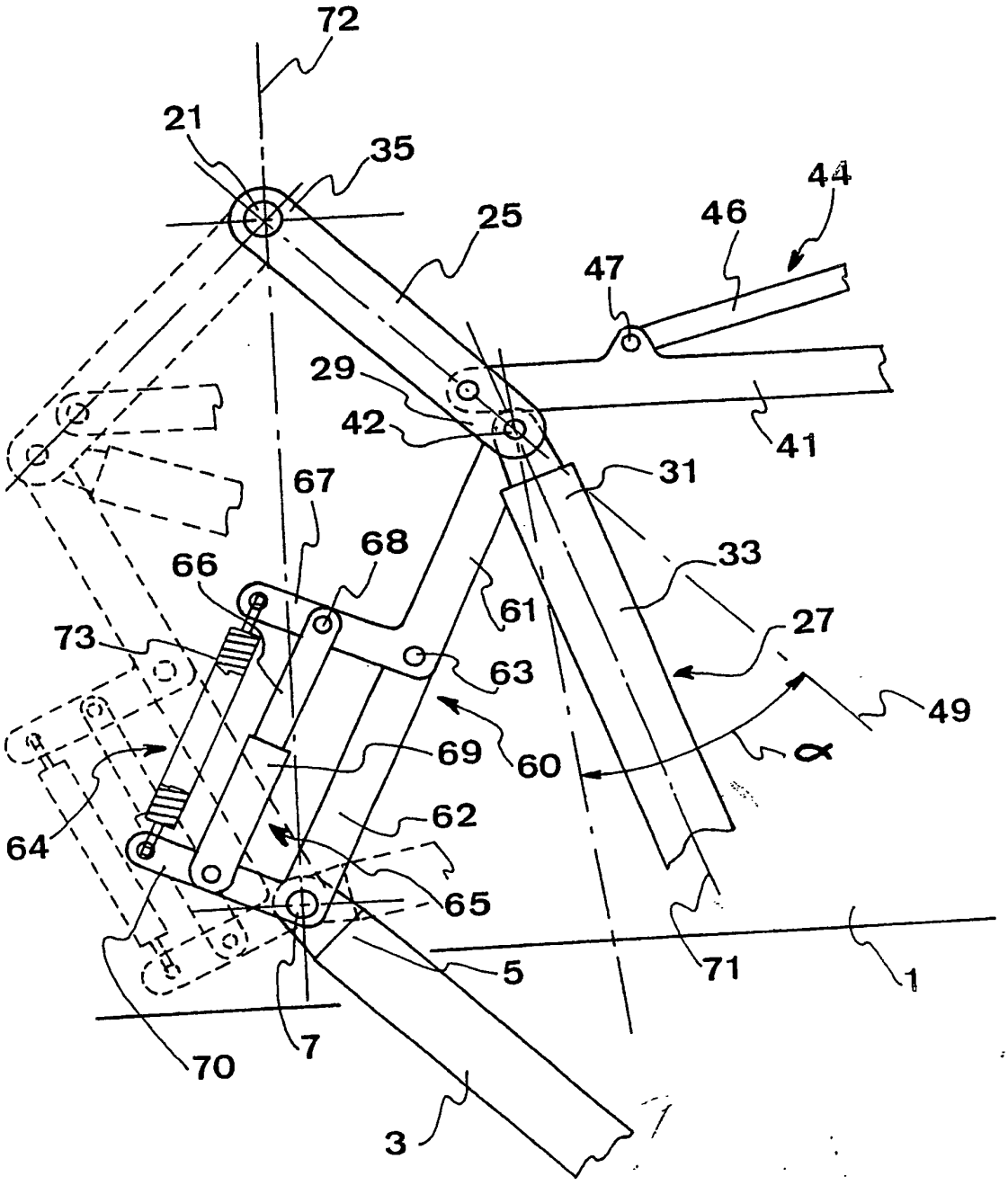
A2
A1
α
P1
P2
27
21
25
42
19
3
15
7

FIG.4


72
21
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44
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31
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73
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49
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60
α
64
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71
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70
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SPECIFICATION

Fuselage mounted undercarriage with tandem wheels

The invention relates to retractable undercarriages for aircraft and more particularly to fuselage mounted undercarriages with wheels mounted in tandem.

Embodiments of such undercarriages are known from the prior art and are generally installed on aircraft intended for very short trips and which are commonly referred to as commuters.

Among the prior art embodiments, there are none which fulfill all the criteria regarding solidity, reliability, minimum size and manufacturing simplicity.

According to the invention there is provided a fuselage mounted undercarriage with wheels mounted in tandem for an aircraft having a rigid structure, comprising at least two rocker beams each capable of pivoting about one of its ends about a respective fixed first axis incorporated in the structure of the aircraft and having the other of its ends supporting rolling means, respective connection means between a respective connection position on each of the two rocker beams to a respective fixed second axis incorporated in the structure of said aircraft, wherein each of the connection means comprise a respective lever and a respective shock absorber pivotably connected together at one of their ends by a pivot, the other end of the two levers each being pivoted to the aircraft about said respective fixed second axis and the other end of each of the two shock absorbers being connected to said respective connection position, a connecting rod of constant length linking the two levers and means for applying a force to at least one of the two levers to cause it to pivot about its respective second axis.

The invention is diagrammatically illustrated by way of example with reference to the accompanying drawings, in which:—

Figures 1 and 2 show respectively a side view and a front view of one embodiment of a fuselage mounted undercarriage according to the invention mounted on an aircraft;

Figure 3 is an explanatory diagram to assist understanding of the operation and advantages of the undercarriage of Figs. 1 and 2; and

Figure 4 shows part of another embodiment of a fuselage mounted undercarriage according to the invention.

It is first of all pointed out that although the third figure is schematic, Figs. 1 to 3 all show the same embodiment of a main undercarriage and consequently the same references designate the same elements. It is also to be noted that in Fig. 1, the full lines show the undercarriage in its "extended" position, while dotted lines show the undercarriage in its "retracted" position.

The undercarriage shown in Figs. 1 and 2 is intended for an aircraft having a rigid structure 1 forming a frame on which will be fixed means for mounting a main undercarriage 2. The main undercarriage includes two rocker beams 3, 4 each mounted at a respective first end 5, 6 on a respective pin 7, 8. The pins 7, 8 are incorporated in the aircraft structure 1 and each defines a first fixed axis.

The respective second end 9, 10 of the two rocker beams 3, 4 includes an axle 11, 12 for rolling means, for example a wheel 13, 14 on which is mounted a tyre 15, 16.

In Fig. 2 it is seen that the axle 11, 12 makes it possible to maintain the tyres 15, 16 away from the rocker beams 3, 4 and in a plane 17 at a lateral spacing from the general plane 18 of each rocker beam 3, 4.

The undercarriage also includes connection means 19, 20 between two respective pivot positions 21, 22 incorporated in the aircraft structure 1 and two other pivot positions 23, 24 respectively incorporated in the rocker beams 3, 4. The pivot positions 21, 22 each define a second fixed axis.

The two connection means 19, 20 are substantially identical and each includes a lever 25, 26 associated in rotation with a shock absorber 27, 28. For this purpose, one end 29, 30 of each lever 25, 26 is mounted swivellably respectively at one end 31, 32, preferably the cylinder 33, 34, of the respective shock absorber 27, 28 and the other end 35, 36 of each lever 25, 26 is mounted swivellably respectively at the pivot position 21, 22 incorporated in the frame 1. The other end 37, 39 of each shock absorber 27, 28, as shown the rod 38, 40, is connected swivellably to said other pivot position 23, 24 respectively incorporated in the two rocker beams 3, 4.

The undercarriage also includes a connecting rod 41 of constant length linking the two levers 25, 26 and connected thereto at a respective position 42, 43 so that the four positions 21, 22, 43, 42 advantageously form a parallelogram. It is to be noted that the swivelling positions of the levers 25, 26 in relation to the shock absorbers 27, 28 can be the same as the positions 42, 43 of the connecting rod 41.

Since the means for attaching the two levers 25, 26 respectively at the positions 21, 22 and the rod 41 at the positions 42, 43 allow free rotation, the parallelogram defined above is a deformable parallelogram.

It is deformed, for example when a force is applied on one of the three elements forming the parallelogram, namely the two levers 25, 26 and the connecting rod 41.

As will be described below, the means for directly or indirectly applying a force to these levers 25, 26 to make them swivel respectively around the positions 21, 22 comprises

an actuating cylinder 44 of which one end 45 can be fixed in rotation but advantageously on a fixed position of the aircraft structure 1, for example on the axis located at the position 22, while the other end 46 of the actuating cylinder 44 is fixed at a position 47 near the pivot position 42 defined previously, either on the lever 25 or on the connecting rod 41.

It will be seen that the actuating cylinder 44 is located substantially along a diagonal of the parallelogram defined above.

Although not essential, the positions 21, 22, 42, 43, 47, 7 and 8 all lie in the same plane 18, thereby allowing the component parts of this undercarriage, which swivel, to be mounted on axes of rotation which are all substantially parallel which unquestionably constitutes a design advantage. The undercarriage shown in Figs. 1 and 2 operates in the following manner in moving from its extended position to its retracted position and *vice versa*.

Assuming that the undercarriage is initially in the extended position shown in full lines in Fig. 1, it can be retracted from this position by lengthening the actuating cylinder 44 so that its rod slides out of its cylinder and the distance between its two ends increases. This causes the lever 25 to be turned clockwise around its pivot position 21 and also drives the lever 26 in the same rotation due to the connecting rod 41.

Such rotation of the two levers 25, 26 exerts a pulling force on said one end 31, 32 of the cylinders of the two shock absorbers 27, 28 which in turn produce rotation of the two rocker beams 3, 4 but in a counter-clockwise direction, that is to say a direction contrary to the direction of rotation of the levers 25, 26.

The rotation of the two levers 25, 26 produced by the actuating cylinder 44 is continued until the two wheels have been retracted into the aircraft structure 1 and assume a position as illustrated in Fig. 1 in dotted lines. In this retracted position, the wheels are substantially located over a plane going respectively through the two main pivot positions 7, 8.

It is of course obvious that when the aircraft is moving on a runway, it should not be possible for this landing gear to retract accidentally. For this purpose, the actuating cylinder 44 comprises controllable locking means, such as jaws, shown schematically in Fig. 1 at 48.

In fact, the actuating cylinder 44 is capable of being locked in each of two given positions, corresponding respectively to the extended undercarriage position and to the retracted undercarriage position.

In Fig. 3, the different elements entering into the composition of the undercarriage structure are shown schematically by single lines and this diagram shows other characteristics and advantages of the undercarriage.

It is evident that when the aircraft is moving on a runway, it can encounter a rough surface or bumps which must not cause damage to the aircraft structure 1 nor subject the passengers to undue jolting.

Hence, when the aircraft is moving on a runway and encounters an obstacle, part of the shock is absorbed by the tyres 15, 16 and part by the shock absorbers 27, 28.

In fact, in known manner, when a shock is applied to the respective wheels of one of the two rocker beams 3, 4 it swivels around its pivot 7, 8 since the rod 38, 40 of the shock absorber 27, 28 can be pressed into the cylinder 33, 34.

Each respective rocker beam 3 and 4 can thus swivel around its respective axis 7, 8 substantially between two positions represented in Fig. 1 by P1 and P2 for the rocker beam 3 and P'1 and P'2 for the rocker beam 4. These positions correspond to the two limit positions of the rocker beams when the shock absorbers 27, 28 are either in their expanded position or in their compressed position.

As stated earlier, when the undercarriage is in its extended position, the actuating cylinder 44 is locked and consequently the levers 25, 26 and the rod 41 can be considered to be a rigid part of the aircraft structure 1 and hence do not undergo any deformation. It is thus understandable that part of the forces not absorbed by the shock absorbers is transmitted to the levers 25, 26. These levers 25, 26 are thus advantageously connected respectively to the shock absorbers 27, 28 so that their general direction, as indicated at 49, 50, forms, when they are in this rigid position with the landing gear extended, the bisector of the angle α through which the shock absorbers 27, 28 turn between their two limit positions A1, A'1 and A2, A'2.

Thus, on average, each shock absorber 27, 28 is considered substantially as an extension of the lever 25, 26 with which it is associated and the force is transmitted along the axis of this lever. This lever is hence subjected to a relatively small torsion couple. This couple is in fact the smallest possible because, if the angle which formed the general direction 49, 50 of these levers with that of the shock absorbers were different, it is unquestionable that the couple would then be much greater. It would thus be necessary to strengthen to a greater extent notably the pins at the first pivot positions 21, 22, the actuating cylinder 44 and the connecting rod 41.

The embodiment of undercarriage just described can of course be modified without departing from the invention as defined by the appended claims. It is quite evident in particular that the attachment points, whether on the rigid aircraft structure or the different elements of the undercarriage, will be determined and will be modifiable in order to

optimize the reliability, weight and dimensions of the tandem fuselage mounted undercarriage especially in accordance with the configuration of the aircraft to be equipped.

While the undercarriage described above with reference to Figs. 1 to 3 has been found to operate satisfactorily, it is essential in certain cases, notably for aircraft carrying passengers, to provide the highest possible level of safety.

It is thus absolutely necessary for the undercarriage to extend even when, for example the actuating cylinder 44 is not supplied with hydraulic fluid and, when the undercarriage is extended, that it be incapable of retracting while the aircraft is moving on the ground. To deal with this problem, the undercarriage comprises locking means which can be actuated in at least the extended undercarriage position and preferably in both positions, *i.e.* undercarriage retracted and undercarriage extended.

An embodiment of such locking means is illustrated in Fig. 4.

In the two embodiments, according to Figs. 1 to 3 and to Fig. 4, elements which are common to both bear the same references. Similarly, as in Figs. 1 and 3, unbroken lines represent the undercarriage in its extended position and dotted lines represent the undercarriage in its retracted position.

The locking means comprise a "breaking" struct 60 connecting at least one rigid point of the aircraft structure 1 to a lever of the deformable parallelogram as defined previously. Advantageously, this point is the one on which are fixed in rotation the rocker beams, such as the rocker beam 3, *i.e.* the point 7. In this case, the lever to which the struct 60 is connected is the one which cooperates with this rocker beam. This is done essentially to limit the space requirements.

More precisely, the breaking strut 60 comprises at least two links 61 and 62 mounted pivotably on each other about an axis of rotation 63, and means 64 for applying a force couple on these two links in order to obtain the rotation of one in reltion to the other in a desired manner.

These means 64 comprises a breaking actuating cylinder 65 of which one end, namely the rod 66, is fixed rotatably on an offset lug 67 integral with the link 61 at a point 68 spaced from the axis of rotation 63. The other end of the actuating cylinder 65, namely the cylinder 69, is fixed rotatably on the link 62, for example also but not necessarily on an offset lug 70 integral with the link 62.

It is moreover quite evident that the length of the strut 60 is determined so that the angle formed by the three points 7, 21 and 42 defines the undercarriage in its extended position as desired and that moreover the direction 71 of the shock absorber 27 is always on the same side of the direction 49 of the lever 25 when the shock absorber sweeps the angle α when absorbing force causing rotation of the rocker beam 3. In this manner, the forces transmitted by the shock absorber to the lever 25 always tend to position it so that it pulls on the strut 60.

In this case, the landing gear can remain completely locked when it is in the extended position and is not liable to retract accidentally.

On the other hand, when the undercarriage is to be retracted, the actuating cylinder 65 is operated so that it extends and hence tends to swivel the link 61 in relation to the link 62 to reduce the distance between the two points 7 and 42. Under the action of this force couple, and under the action of the force exerted at the same time by the actuating cylinder 44, the lever 25 swivels around the position 21 and, as explained earlier, the other lever 26 rotates at the same time around the position 22. Once the two links 61 and 62 have been disaligned by the actuating cylinder 65, the actuating cylinder 44 continues to be operated to bring the landing gear to its final retracted position as shown partially in dotted lines in Fig. 4. In this position, the end 29 of the lever 25, when it has passed a line 72 passing through the two points 7 and 21, again pulls on the links 61 and 62 tending to realign them. In this position, the landing gear is locked and cannot extend by itself, this position even being favoured by the action of a tension spring 73 connected between the two lugs 67, 70.

Similarly, to go from the retracted position to the extended position of the undercariage, in a first phase both the actuating cylinder 65 and the actuating cylinder 44 are operated to disalign respectively the two links 61 and 62 and rotate the levers 25 and, in a second phase, only the actuating cylinder 44 is operated in order to bring the lever 25 to the undercarriage extended position, this changeover moreover being assisted after passing through the line 72 by the tension of the spring 73.

In an undercarriage of the kind illustrated in Fig. 4, even in the event of a failure in the pressurised hydraulic fluid supply lines for example, the pilot can, by means of an auxiliary lever, break only the alignment of the links 61 and 62, thereby rotating the lever 25 toward its undercarriage extended position. The weight of the component elements of the undercarriage will lead to its complete extension, aided in this by the sring 73 which contributes to the alignment of the two links 61 and 62 and brings the lever 25 to its position as shown in Fig. 4 for the undercarriage extended position.

The lever 26 of course follows the same trajectory because it is connected by the connecting rod 41 to the lever 25.

It is consequently seen that this undercarri-

age can provide full safety and notably the assurance of extending even in the absence of actuating cylinder drive fluid, and especially that it will lock in this position and remain there permanently.

CLAIMS

1. A fuselage mounted undercarriage with wheels mounted in tandem for an aircraft having a rigid structure, comprising at least two rocker beams each capable of pivoting about one of its ends about a respective fixed first axis incorporated in the structure of the aircraft and having the other of its ends supporting rolling means, respective connection means between a respective connection position on each of the two rocker beams to a respective fixed second axis incorporated in the structure of said aircraft, wherein each of the connection means comprise a respective lever and a respective shock absorber pivotably connected together at one of their ends by a pivot, the other end of the two levers each being pivoted to the aircraft about said respective fixed second axis and the other end of each of the two shock absorbers being connected to said respective connection position, a connecting rod of constant length linking the two levers and means for applying a force to at least one of the two levers to cause it to pivot about its respective second axis.

2. A fuselage mounted undercarriage according to claim 1, wherein the means for applying a force to at least one of the two levers comprises an actuating cylinder having a first end pivoted to a fixed point on the aircraft structure and a second end coupled to said at least one of the two levers, the actuating cylinder being capable of adopting at least two positions determining two limit lengths, the two limit lengths corresponding respectively to a retracted position and an extended position of the undercarriage.

3. A fuselage mounted undercarriage according to claim 2, wherein the second end of the actuating cylinder is mounted on a pin located adjacent the pivot connection between said at least one of the levers and the respective shock absorber.

4. A fuselage mounted undercarriage according to claim 3, wherein the second end of the actuating cylinder is mounted pivotably on said one of the levers.

5. A fuselage mounted undercarriage according to claim 3, wherein the second end of the actuating cylinder is mounted pivotably on the connecting rod.

6. A fuselage mounted undercarriage according to any one of claims 2 to 5, wherein said first end of the actuating cylinder is mounted at one of said fixed second axes.

7. A fuselage mounted undercarriage according to any one of claims 2 to 6, wherein when the actuating cylinder is operated so that its length sets the extended undercarriage position, the direction of the levers is defined so that each forms substantially the bisector of the angle through which the respective shock absorber can be turned between a fully extended position and a fully compressed position of the shock absorber.

8. A fuselage mounted undercarriage according to any one of claims 2 to 7, wherein the connecting rod is connected respectively to the two levers by two connection positions which form with the two fixed second axes a deformable parallelogram.

9. A fuselage mounted undercarriage according to any one of claims 2 to 8, wherein the actuating cylinder locking means controllable to lock the actuating cylinder in at least one position thereof.

10. A fuselage mounted undercarriage according to claim 9, wherein the locking means are of the jaw type.

11. A fuselage mounted undercarriage according to any one of claims 2 to 6, further comprising means for locking the undercarriage in at least one of the retracted and extended positions thereof.

12. A fuselage mounted undercarriage according to claim 11, wherein the locking means comprise a "breaking" strut of fixed length connecting a fixed point on the structure of the aircraft to a point on one of the two levers.

13. A fuselage mounted undercarriage according to claim 12, wherein the breaking strut is made up of at least two links pivotably connected together and each connected to one of said fixed point and said point on one of the two levers.

14. A fuselage mounted undercarriage according to claim 12 or claim 13, wherein said fixed point coincides with one of said first axes, and said point or one of the levers is located on that one of the levers which is connected to that one of the shock absorbers which is connected to that one of the rocker beams which can pivot about said one of the first axes.

15. A fuselage mounted undercarriage according to claim 13 or claim 14, further comprising breaking means for exerting a first force couple on the two said links to rotate them in relation to each other.

16. A fuselage mounted undercarriage according to claim 15, wherein said breaking means include at least one breaking actuating cylinder and means for connecting the two ends of said breaking actuating cylinder with the two said links at points not coinciding with the position at which the two links are pivotably connected together.

17. A fuselage mounted undercarriage according to claim 16, wherein said breaking actuating cylinder has means for determining the length of its stroke.

18. A fuselage mounted undercarriage according to any one of claims 15 to 17, further

comprising at least one tension spring exerting a second force couple on the two said links to load them constantly so as to rotate in the same direction.

19. A fuselage mounted undercarriage with wheels mounted in tandem for an aircraft having a rigid structure substantially as hereinbefore described and illustrated with reference to the accompanying drawings.

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